THE

Indian Tea Association.

SCIENTIFIC DEPARTMENT

QUARTERLY JOURNAL.

PART I.

1915.

Calcutta:
PRINTED AT THE CATHOLIC ORPHAN PRESS
3 & 4 Portuguese Church Street.

1915.

CONTENTS.

ON INSECTS

BY

E. A. ANDREWS, B.A.

Part III.

(Continued from Vol. III, 1913, p. 42.)

The third order of insects is known as the *Neuroptera*, and its members are characterised by having biting mouth-parts, and two pairs of membranous wings provided with numerous veins. This order contains many families whose relationships are not clearly understood, and as to the classification of which there is much difference of opinion. Some of them resemble the *Orthoptera** in structure and development, while others bear considerable resemblance to the *Lepidoptera* (butterflies and moths). Some of the forms are wingless, while others possess wings. Some undergo a more or less complete metamorphosis,† that is to say, they have distinct larval, pupal, and imaginal or adult stages, while others emerge from the egg in a form very similar to that of the adult, which form they retain, except for alterations in detail, throughout their life-history. The various families are classified, for convenience, into groups as follows :—

No Metamorphosis

1.	*Mallophaga*		... Bird lice.
2.	*Pseudoneuroptera*	*Embiidae*	
		Termitidae	... White ants or Termites.
		Psocidae	... Book-lice, Death-watches.
3.	*Neuroptera amphibiotica.*	*Perlidae*	... Stone-flies.
		Odonata	... Dragon-flies.
		Ephemeridae	May-flies.

* See Part II. (Vol. III, 1913, p. 35.)

† See Part II. (Vol. III, 1913, p. 33.)

Metamorphosis

4. *Neuroptera planipennia.*	*Sialidae* ...	Alder-flies.
	Panorpidae	Scorpion-flies.
	Hemerobiidae	Lace-wing flies, Ant lions, &c.,
5. *Neuroptera trichoptera.*	*Phryganeidae*	Caddis flies.

Only two of the above families, the *Termitidae* and *Psocidae*, contain members which have been found to attack the tea plant, but certain of the other families, the *Odonata* and *Hemerobiidae*, contain members which, by feeding on other insects, afford a certain amount of assistance in keeping down pests of various kinds.

Mallophaga.—Bird-lice or biting-lice. These are small, flattened, wingless insects bearing a superficial resemblance to the ordinary head-louse. The latter, however, belongs to a different order of insects, and sucks the blood of its host, whereas the former are provided with distinct jaws, and feed on the feathers, skin, and scurf of their host. The *Mallophaga* are chiefly confined to birds, but a few have been found on mammals. Very little is known of the life-history of these curious insects, as they never leave the body of the host, and die very soon after the bird is killed, or if removed from the living body. The egg is attached to the feathers, and the young bears a remarkable resemblance to the adult. By their movements and by constantly biting the skin lice cause serious irritation which weakens the host and renders it liable to various diseases. Chicks affected by lice are greatly weakened, and very subject to diarrhœa. Howlett* recommends that fowls, &c., which are infested with bird-lice should be carefully brushed with a non-irritant vegetable oil (not paraffin or crude oil). American authors suggest dressing the fowls with kerosene, or a mixture of plaster of Paris and carbolic acid, or slaked lime and sulphur, and at a recent meeting of the Texas State Farmers' Institute the methods recommended were (1) to dip the fowls into a 2 per cent solution of chlorine (2) to dust the fowls with a powder prepared by mixing one pint of a 2 per cent

* "Indian Insect Life" 1909, p. 113.

solution of chlorine with half a pint of gasolene, and adding as much air-slaked lime to the mixture as it will take up, stirring thoroughly whilst it is being added. The powder should be used sparingly.

Embiidae.—These are small delicate insects which occasionally come to light, but are not likely to be noticed by the casual observer. Very little is known about them.

*Termitidae.**—Termites, or White Ants. These insects are included in the order *Neuroptera* chiefly on account of the structure of the wings of the males and females, of which there are four, similar in size and appearance, which lie flat on the back when the insect is at rest, and extend beyond the posterior extremity of the body. In their general structure, and in the arrangement of the mouth parts, they bear more resemblance to the *Orthoptera*†, and in their mode of life they resemble the ants, which are included in an order of insects (the *Hymenoptera*) to be described later. Termites are familiar, to a certain extent, to all who have lived in India. The small white workers and soldiers, with their brown heads, which are to be seen running about in all directions when a nest is opened, and the winged adults which emerge in myriads at the advent of the rains, are well known to every tea planter. Yet, in spite of the fact that the damage done annually to crops in British India alone, runs into millions of pounds sterling, it is only of recent years that the study of termites has been undertaken systematically, and even now comparatively little is known with certainty of the economy of these insects. The winged forms, which emerge in swarms at the beginning of the rainy season, are the sexual members of the community, the males and females. They possess biting mouth parts, and compound and single eyes, and are characterised by the presence of the two pairs of similar wings referred to above. At the base of each wing is a kind of imperfect joint, or line of weakness, and the wings can be voluntarily severed by the insect at this line. These winged forms pair off at the time of

* See Indian Tea Association Scientific Department Quarterly Journal, 1912, p. 97, 1913, p. 96.

† See Part II. ib., 1913, p. 35.

swarming, cast their wings, and enter the ground. Three or four days afterwards they may be found some six inches to a foot below the surface, the depth varying with different species. Here they construct a small nest, and the female lays a few eggs, which develop into 'workers' (see below.) These assist in the construction of the nest, and in looking after further batches of eggs, and when the nest has become sufficiently well established the female begins to increase in size, and ceases to take an active part in its construction. This increase in size is caused by growth of the generative organs, and goes on until the insect becomes a helpless sac of eggs, incapable of movment, which must be fed and tended by the active workers. In this state she may exist, as the 'queen termite' of the colony, for years, extruding eggs continuously. The male does not increase in size, but after a time he also ceases to be an active member of the colony, and lives, with the queen, in a special cell which is known as the 'royal cell,' he being known as the 'king termite.'

The eggs which are laid by the queen give rise to three types of individual, known respectively as 'workers,' 'soldiers,' and 'nymphs.' The first two types form the active portion of the community, and are the small insects which are to be seen running about the nest when it is broken into. In general appearance they are somewhat similar, the head being brown, the body segments distinct. In the worker, however, the jaws are adapted for biting and chewing, while in the soldier the mandibles are prolonged into a formidable-looking pair of prongs, eminently fitted, in appearance at any rate, for purposes of attack and defence. The head of the soldier, too, is usually larger than that of the worker. The nymphs are the young of the sexual form, and differ from them only by the absence, or in the rudimentary condition of, the wings. Small milk-white active forms, which are also to be seen in a termite's nest, are the young of the soldiers and workers.

The workers, soldiers, and winged sexual forms are the three types, or 'castes,' as they are called, of members found in termite communities, but there is great variety, in different species, in the relative proportions of the different 'castes.' In some species, too, there may be two kinds of worker, in others two kinds of soldier,

and some of the nymphs may never leave the nest at all, but be fertilised there and remain as 'accessory' or 'substitution' queens. It has been popularly supposed that the several castes of termites always hatch from the eggs in the same form, and that the differentiation into castes is brought about after birth by some difference in the mode of feeding, but recent researches have shown, in the case of *Eutermes* and *Termes* at any rate, that the young soldier hatches from the egg in a form resembling the fullgrown soldier, and that differentiation must therefore take place in these forms during the egg stage. This is probably the case with the worker also, but still remains to be proved.

The workers, as their name implies, are the working members of the community. They are incapable of reproducing their kind, and all their energies are devoted to the construction of the nest, the obtaining of food, and rearing the young termites. The soldiers are also incapable of reproduction, and their function appears to be the defence of the colony. The winged forms take no active part in the economy of the nest, and their duty is to reproduce and disseminate the species.

The white ants which attack tea may be divided into two groups, those which build a mound and those which do not. In each of these groups there are several species, and until every species has been properly worked out it is impossible to give a detailed description of the nest of each. A general description of a termite nest may, however, be of interest. On opening up the soil the first thing to be seen is a number of galleries, running in all directions. These communicate with a few main galleries leading down into the nest. A little further digging will bring to view cells or chambers, containing a dark grey spongy mass covered with small white globules. This spongy mass is known as the 'comb,' and is composed of small grains of masticated organic matter cemented together. The white globules are fungi, which the termites are supposed to cultivate for food. It seems probable, in fact, that the depredations caused by termites are due, not to their actually feeding on the substance attacked, but to their removing the material for the purpose of constructing the comb on which the fungi are grown. These fungi are found in all termite

nests, and the very young termites and nymphs are almost invariably to be found in a chamber containing a fungus comb. At some part of the nest will be found a smooth chamber containing the king and queen. This is the royal cell. A network of galleries connects the various chambers with the surface and with one another. The disposition of the chambers in the nest varies in different species, and to a certain extent in different nests of the same species, and the general shape of the nest may of course vary according to circumstances.

Termites must play a very important part in the economy of nature, by helping to bring about rapid disintegration of dead vegetable matter, by taking it down into the soil, and by bringing subsoil to the surface. In tea gardens, however, where the available vegetable matter consists mainly of the tea bushes and shade trees, the insects, in their search for material, are apt to go beyond the limits of usefulness and become a nuisance by infesting the bushes. Any dead snag on a bush is immediately attacked, and provides a direct means of entry to the heart wood. This may be eaten away and the sap-wood left, and the bush, though hollow and full of termites, continues to flush. As the insects work along they put a layer of earth against the sap wood, which dries the latter, hinders the free circulation of the sap, and weakens the bush still further. This process goes on until the bush is killed. In other cases, the insects obtain entry into a branch at a wound, caused, may be, by a slip of the knife in pruning, by a blow from a hoe, by cattle, or by a boring insect. By means of a layer of soil on the wound they extract moisture from the spot and prevent the process of healing. As the outside wood dies it is eaten away, and eventually the flow of sap past the wound is prevented, and the upper part of the branch dies back. The lower part is killed more gradually, but the termites work along it until they get to the heart of the bush. Another means of entry is by way of an injured root. At certain times of the year, especially towards the end of the plucking season, the bushes become noticeably full of 'white-ant mutty.' This may be accounted for by the fact that cultivation is more or less at a standstill at this period, and of course with

the cessation of the heavy rains it becomes possible for the termites to build in the bushes. The removal of moisture from living wood, too, would be a difficult if not impossible task during the rainy season. Close observation leads one to believe that the objective of the white ant runs found on the bushes during the cold weather, is the dead wood which is to be found there, and in the majority of cases these runs can be traced to some piece of dead wood, either a snag left at the last pruning or a branch which has been broken or has died back, or to some place where a branch has suffered injury. Very often the branches covered by these runs show no signs of injury, but in some cases the outer layer of bark is found to have become dry, and to have been partly removed. When young bushes are planted out, it is found that those planted on white ant 'teelas' grow sickly and finally die out. When dug up they may or may not show signs of termite attack, such attack being a consequence, and not the cause, of the death of the plant. Certain other crops, on the other hand, grow better on this soil than on the surrounding soil. This may be due to the fact that the white ant soil, though chemically as rich or even richer than the surrounding soil, is mechanically unsuited for tea, and that an alteration in its texture may be necessary before tea can be successfully grown on it. The matter is under investigation.

Many remedies have been tried against these pests, but so far with only a small measure of success. Substances which have been found to have some effect as deterrents in the case of termites attacking trees are, a ten per cent. solution of sodium arsenite, kainit, 'Terracide,' and a mixture of corrosive sublimate and sugar. Oil cake seems to be obnoxious to these insects in a small degree. Posts can be more or less protected from the inroads of white ants for two or even three years by thorough soaking in either a saturated solution of bluestone (copper sulphate), or a ten per cent. solution of sodium arsenite, or Atlas compound, and railway sleepers are treated by exhausting the cells of the wood, as far as possible, of air, and replacing this air by creosote.

One method of destroying termites, the method of fumigation, has been found successful against species which build a nest

which can be readily located. An account of an experiment with a machine designed for this purpose has been given in a previous number of this journal,* and the same machine has since been used on several occasions with success. Although no practical method of destroying or driving away termites on a large scale has yet been devised, their attacks can be mitigated, to a great extent, by care and attention at the time of pruning, and by thorough cultivation and thullying round the bushes.

Psocidae.—This family includes the book lice and death watches, and contains at least one species which attacks tea in the field. The members of this family are small delicate insects with hair-like antennæ, and four membranous wings, of which the front pair is the larger. When the insect is at rest the wings lie over the sides of the body, with the hind edges meeting in a line over the middle of the back. Metamorphosis is slight, and the young very much resemble the adult. *Psocus taprobanes*† Hagen, is a species which occasionally attacks tea in Assam and the Duars, congregating on the stems of the bushes and eating the bark. Another species‡ has been found to attack stored tea dust in Assam.

Perlidae.—The stone-flies are not likely to come before the notice of the tea planter. They are moderately large insects, having four membranous wings, each with a network of veins, the hind pair being larger than the front pair, and folding beneath them when the insect is at rest. They live in water in the larval stages.

Odonata.—Dragon-flies are common in the tea districts, and play a useful rôle in devouring various plant-feeding insects. They are easily recognised by the long narrow body, the large mobile head with its enormous eyes, and the two pairs of membranous wings, which are held horizontally at right angles to the body when the insect is at rest, as well as during flight. All the legs are placed very far forward, in front of the wings, and are practi-

* Part IV, 1913, p. 96.

† See Indian Tea Association, Scientific Department Quarterly Journal, Part I, 1912, p. 24.

‡ See Indian Tea Association, Scientific Department Quarterly Journal, Part III, 1914, p. 114.

cally useless for purposes of locomotion. In the early stages of their life history dragon-flies live in water. The eggs are laid in water, in masses, each mass enclosed in a transparent slimy covering. The larvæ are very active, wingless, with a longish body and three pairs of legs, and the front of the mouth is concealed by a peculiar structure known as the 'mask.' This is a jointed structure which is a development of the lower lip, and it can be thrust out suddenly to catch the insect's prey, which is then drawn up to the mouth to be devoured. There is no definite pupal or chrysalis stage. The larva moults several times, and when it is full grown it climbs up the stem of an aquatic plant, and the perfect insect begins to emerge almost immediately. Dragonflies are usually brightly coloured.

Ephemeridae.—May-flies.—These are common in the tea districts, and are easily recognised by the delicate transparent wing s which are held in a vertical plane when the insect is at rest, and by the fragile tapering body terminating in two or three long delicate hair-like processes. The mouth parts are either feebly-developed or absent, and the insect does not feed in the adult stage. The eggs are laid in water, and give rise to slender larvæ, which have long antennæ, biting mouth parts, and usually long processes from the end of the abdomen. The larvæ are provided with peculiar projections which function as gills, and undergo a large number of moults before becoming full-grown. The full-grown larva, or 'nymph,' comes to the surface, and a flying insect emerges which is known as the 'sub-imago.' This flies away and settles, and, shedding a delicate skin, gives rise to the perfect insect.

Sialidae.—An unimportant family of insects in India, not at all likely to attract the attention of the tea planter.

Panorpidae.—The scorpion-flies, though uncommon, are worthy of mention on account of their peculiar appearance, which may attract the attention of even the most casual observer. The head is prolonged into a tapering break, at the end of which is a biting mouth. There are two pairs of wings of equal size, which are held at an angle to the body, and the body of the male is long and slender, with the last joint swollen

and the end joints turned up and curled over the back like the tail of a scorpion. They are predaceous, and feed on other insects. The larva lives in the soil, and feeds on decaying vegetable matter. In appearance it somewhat resembles a caterpillar. There is a distinct pupa, found also in the soil.

Hemerobiidae—This family is composed of a miscellaneous assemblage of sub-families, having very little in common beyond a general similarity in the life-history and in the structure of the mouth parts of the larvæ. It includes three forms likely to be of interest to planters in North East India, the ant-lions, (*Myrmeleoninae*), the lace-wing flies (*Chrysopinae*) and forms (*Mantispinae*) which resemble the praying mantis. The Ant-lions, in the larval stage, construct conical pits in sand, at the bottom of which they lie concealed. Small insects, such as ants, &c., fall into these pits, and are seized and devoured. These pits are common beneath the chungs of bungalows in Assam. A species of lace-wing fly, very common in the tea districts, is worthy of mention as the larva feeds on red spider, aphids, &c. The eggs of this species are to be found on the leaves of the tea bush. They are oval and milky white, and are attached to the leaves by a white slender thread. Most planters will have noticed, on the leaves of the tea bushes, a fine stiff white thread with a white knob at the end, like a tiny drumstick. The knob of the drum-stick is the egg of *Chrysopa*, the lace-wing fly. From this egg emerges an active slender larva, with six long legs, a pair of long curved jaws, and the body covered with spines. This sucks the body juices from its prey, and then sticks the empty skin on to its back, where it is held by the spines. After a time the insect is almost entirely concealed by the accumulation of skins. Lace-wing larvæ are very voracious, and one larva will account for an enormous number of victims. At the end of about a week the larva forms an oval white cocoon, made of silk, which is situated on the bush, and a month or so later the perfect insect emerges. The adult, which is commonly found round the bungalow lamps in the evening, has a slender green body and a pair of large transparent wings, with a greenish tinge and many veins. The wings are very large compared with the size of the insect, and when the insect is at rest they cover the

body like the roof of a tent. The *Mantispinae* bear a superficial resemblance to the praying mantis in that the front pair of legs is of similar construction. They are easily distinguished, however, by the fact that the first segment of the thorax is not elongated, and by the structure of the wings. In the true mantids the front pair of wings is thickened and modified to form wing covers, while the hind pair is much larger and membranous. In the *Mantispinae* both pairs of wings are membranous and transparent, and of approximately equal size. The *Mantispinae* are predaceous, but whether they may be classed as beneficial insects is doubtful, as the larvæ feed on the eggs and young of spiders.

Phryganeidae—Caddis-flies—These are all aquatic in the young stages, and every one is familiar with the 'caddis worm' of Europe. They are of no importance in the tea districts.

FUNGI PARASITIC ON THE TEA PLANT IN NORTH EAST INDIA

BY

A. C. TUNSTALL, B. SC.

*Part V.**

BASIDIOMYCETES.

It will be remembered that the *Ascomycetes* were characterised by a particular form of fruiting structure known as an *ascus*. In the *Basidiomycetes* instead of the spores being produced in special protecting structures such as asci they are borne at the ends of little horns on a structure known as a *basidium*. The basidia are produced side by side in a special layer known as the *hymenium*. This layer is protected in various ways. In some fungi (e.g., the mush-rooms) it is borne on plates, arranged like the gills of a fish beneath a protecting cap: in others (e.g., the bracket fungi) it lines the inner surfaces of tubes. Besides the spores produced on basidia (*basidiospores*) there are frequently others, as many as five varieties of the spores in some genera.

The vegetative part of *Basidiomycetes* has a peculiarity. In many of the septa of the hypha (filaments) the end of the preceding cell overlaps the following one as though the cells were clamped together.

There are in addition to the *Basidiomycetes* proper a number of fungi which cannot be classed as true *Basidiomycetes* but are grouped together under the term *Hemibasidiomycetes*.

HEMIBASIDIOMYCETES.

According to the information we have at present, no *Hemibasidiomycetes* are found as parasites on the tea plant, although some of the most important fungus blights in the world are caused by

* Continued from page 98 of the last issue of this journal.

fungi belonging to this group. The most important members cause the smuts of cereal crops and are responsible for the loss of millions of pounds sterling every year. These diseases are caused by various species of the order *Ustilagineae*.

Another order which is considered by some authorities as belonging to the *Hemibasidiomycetes* is the *Uredineae*. This order which contains the very numerous rust fungi also causes very heavy losses every year. There are at least two thousand species but so far none have been found parasitic on tea. The well known Red Rust of tea is caused by another organism altogether. Many of the plants commonly used as green manures are attacked by members of this order and the life history of a typical rust fungus is briefly as follows :

They are small fungi, mostly microscopic, parasitic on the tissues of higher plants. The mycelium lives in the spaces between the cells of the host plant sending special absorbing organs into the cells. Typically there are five different sorts of spores produced.

1. basidiospores.
2. pycnidiospores.
3. aecidiospores.
4. urediniospores or uredospores.
5. teleospores or teleutospores.

The mycelium arising from a basidiospore invades the host plant. Later on it produces spore beds known as *aecidia* usually sunk deep in the tissues of the plant. When the aecidiospores are ripe the epidermis is ruptured and they escape. The aecidia and aecidiospores are usually red or yellow.

Along with the aecidia or sometimes with other formations small cavities (*pycnidia*) containing spores called *spermatia* or *pycnidiospores* are formed. These have no power of germination and were at one time considered to be degenerated male organs; hence the term **spermatia.**

The *aecidiospores* produced by a rust fungus on a particular plant may infect plants of the same species or of an entirely different species and spores are produced on these.

Uredospores or *urediniospores* develop on these. These spores may reproduce the uredo stage throughout the growing season. They are usually short lived and apparently provide for the spread of the fungus during the summer. In some species special uredospores are produced having thickened walls and able to resist unfavourable conditions.

At the end of the summer the fungus produces still another kind of spores called *teleospores* or *teleutospores* which are usually produced along with the uredospores, frequently from the same spot. Teleutospores are thick-walled and do not germinate until after a period of rest. They are specially prepared to survive the dry or cold season.

The teleutospores on germination produce a short germ-tube which soon becomes divided by septa (dividing walls) into four parts; each of these divisions sends out a short branch on which a basidiospore develops. The germ-tube therefore becomes a basidium. The basidiospores recommence the life cycle. The various stages mentioned above are in some species spent on a single host plant, but in many cases attack two or sometimes three hosts of entirely different species, spending one or perhaps two stages on one host and the others on an entirely different one.

It will be readily understood that fungi having so many devices for tiding over unsuitable conditions are very difficult to deal with. In most cases the difficulty is being overcome by the breeding of plants immune to their attacks. In others it has been found that the removal of one of the alternate hosts eradicates the fungus as the latter is then unable to complete its life cycle.

Basidiomycetes.

In the *Hemibasidiomycetes* the basidium is more or less rudimentary but in the true *Basidiomycetes* it is more highly developed and its form more definite. The basidia are produced side by side thus forming a definitel layer known as the *hymenium*. As mentioned above this layer is frequently arranged so that it is protected. The simplest family of this group has no device for affording protection to the spores, the spores being produced on a fully exposed surface. The fungus which causes blister-blight belongs to this family.

Blister Blight.

Exobasidium vexans.—The fungus attacks the leaves and stems of the plant, living wholly within the tissues except at the fruiting period, causing white convex warts. These warts later turn black. Sometimes especially in the case of leaves, the black portion falls out leaving a hole. The life history of the disease is very simple—a spore falling on a leaf or stem germinates and sends out a delicate thread which either forces its way through the epidermis or enters through the stomata (mouth-like pores). The fungus then develops within the tissues causing a semitransparent spot. In ten or eleven days' time the fungus forces its way through the epidermis and produces spores. Two kinds of spores are produced simultaneously —the characteristic basidiospores and conidiospores. The basidium has four horns each carrying a colourless spore which is oval at the ends and curves slightly in the middle. The conidiospores which are slightly smaller than the basidiospores are borne singly at the ends of hyphæ. They are oval and colourless. The conidiospores and basidiospores are produced side by side. Both germinate equally well. No other kind of spore has been observed.

The fungus is only able to infect young succulent growth—the older leaves and stems being immune. Though many attempts have been made to innoculate jungle plants with this fungus, so far they have not been successful. The spores are shortlived—losing their power of germination even under favourable conditions in two or three days. The fungus does not persist for any appreciable time in the living or dead plant tissues after the spores have

fallen. It is therefore concluded that the disease is only capable of continuing its existence in an active stage. On many tea gardens in Assam the disease dies out of its own accord, only reappearing when spores of the fungus are reintroduced from other gardens. In the hilly districts the weather conditions are more favourable to the fungus, and at any time of the year active blisters may be found on bushes growing in damp shady places. Under favourable conditions the disease spreads with terrible rapidity.

Desmodium Polycarpum.

GREEN MANURES

BY

G. D. HOPE, B. SC., PH. D., F.C.S.,

AND

A. C. TUNSTALL, B. SC.

Part II.

THE TRIAL OF JUNGLE PLANTS AS GREEN MANURE CROPS.

Several most successful green manure crops have been originally obtained from jungle growing near the place where they were first used and it would seem probable that many more suitable plants may yet be had from the same source. The normal habit of such plants may be observed as they grow in their natural habitat. The time of flowering, the rapidity of their growth, their succulency, their root development and so on, can be noted but it must be remembered that the habit of growth of plants tends to change under altered conditions of environment and the nature of the growth of plants when used for growing on cultivated ground, and their suitability to the changed conditions must be studied and can only be discovered by experiment.

DESMODIUM POLYCARPUM.

As an example of a jungle plant which may prove to be a satisfactory green manure crop we will describe *Desmodium polycarpum* (see illustration). Trifoliate leaves somewhat like those of clover are borne on long trailing stems which do not twine. The roots bear nodules in abundance. The flowers are small and of the shape of pea flowers and are produced at the close of the rainy

* A series of articles on green manures and green manuring have appeared in the Quarterly Journals and it is proposed to continue to write from time to time notes and suggestions on this subject under the heading "Green Manures." Eventually the information so collected will be published in a more systematised form as a pamphlet.

season. The seed is small and produced in pods which are clustered together at the ends of the shoots. When ripe the pods break up into segments each containing one seed. The pods ripen in November and December.

The plant is distributed throughout the tea districts on all classes of soil and in both sunny and shady places. In Darjeeling it is usually found growing wild on the faces of terraces while in the plains it seems to prefer thatch land. It is also found in the shade of dense jungle.

The seed is very small and unless the soil be carefully prepared in all probability a great deal will be lost. Last year it was determined by experiment that the plant grows well from cuttings and as it is usually very plentiful in the jungle this method of propagation may be found feasible. The normal habit of the plant suggests its possible usefulness as a cover plant for the faces of of terraces. The cuttings may be planted at intervals of two feet at the bottom of the faces. The stems will grow upwards and when of sufficient lengths may be trained across one another thus forming a net work. They may then be layered by pushing them into the soil at intervals, an operation which should be carried out in wet weather.

An illustration of a young plant of *Desmodium polycarpum* faces page 17.

RECENT TOURS.

Entomologist.

The Advisory Tour referred to in the previous number of this Journal was continued in December. The Entomologist was in the Luskerpore Valley from the 9th to the 13th of the month. Several gardens were visited, and on the 12th a short address was delivered at the Chundeecherra Club. Twenty members attended. On the 14th the Entomologist reached the Chittagong district, and visited several gardens, leaving for headquarters on the 19th. Mosquito blight is not known as a pest in these districts, although traces of it were found in Chittagong, but extensive damage is done by white ants.

During the first week of February the Entomologist attended an informal conference of Entomologists at Pusa, at which the life histories and methods of control of the various insect pests which affect crops in India were discussed.

Mycologist.

The Mycologist recently paid a short visit to Nowgong district for the purpose of research in connection with tea roots. He is noting the relationship between the morphological characteristics of tea roots growing on soils of different chemical and mechanical compositions. The Mycologist has recently paid a special visit to Cachar and Sylhet to investigate the condition of tea seed gardens.

NOTES.

The Treatment of Albizzia stipulata (Sau trees).—It is generally recognised that on many soils sau trees have a markedly beneficial effect on tea outturn. The good health of these trees is therefore important. Sau trees, like other trees, have their diseases, and it should be the aim of every planter to reduce these to a minimum.

The most obvious disease is that popularly referred to as canker. This usually first makes its appearance as a patch of darker colour on the bark, and later on gum exudes from cracks. Finally the wood beneath the patch becomes soft and rotten. Although so far the fungus or fungi causing this disease have not been fully investigated, it seems probable that healthy unbroken bark is not infected. It is therefore desirable to avoid wounds, or, where that is impossible, to take steps to keep them antiseptic until nature heals them. It is of course necessary to prune the trees occasionally so that the tea may not be shaded excessively. This pruning should be carried out as carefully as the pruning of tea; it is unfortunately frequently left to unskilled labour armed with dhaos and axes. All branches which are to be removed should be cut off in such a way that the resulting wound may heal in the minimum time. All large wounds should be protected by an antiseptic coating. Ordinary coal tar applied thinly will be found suitable. It should not be applied too thickly as it then cracks and peels off.

The bark of sau trees is usually encrusted by a mass of mosses and lichens. These, besides being injurious to their host, form excellent harbouring places for many of the pests harmful to tea. It is therefore desirable that the bark be periodically cleaned. An application of copper soda emulsion* would be most suitable for this purpose. One application every two years would be a very useful routine. This spray fluid is both fungicidal and insecticidal.

* See "Notes on the spraying of tea," Publications of the Scientific Department Indian Tea Association 1915.

It is best to apply it immediately after the pruning of the tea. Then, besides removing the organisms present on the bark, it will also disinfect the numerous cuts frequently made by the coolies in the garden.

A. C. T.

Albizzia julibissin. Darazz.—This is a tree similar in general appearance to *Albizzia stipulata*, but the flowers are pink. It is found in Western Asia and in tropical Africa. The Chief Scientific Officer saw it in Mazanderan in North Persia, and in the tea gardens of Trans-Caucasia.

An endeavour is now being made to obtain seed so that this tree may be grown at the Tocklai Experimental Station.

The preparation of Bordeaux mixture.—Various methods of preparing Bordeaux mixture have been described from time to time in this Journal. All the methods mentioned have been tested and found effective as far as their fungicidal properties are concerned, but some are more economical than others. The cheapest as well as the most satisfactory has been found to be that made according to the Woburn formula. A description of this may be found in the pamphlet entitled "Notes on the Spraying of Tea." The compound of copper which is formed is basic copper sulphate, not as stated in some books, copper hydrate. It is extremely important that the preparation be made with absolute accuracy otherwise the fungicidal action is retarded, and in the rainy season efficiency may be considerably reduced. In the cold weather it is sometimes desirable that the action should be more prolonged, hence the formula given in this Journal (1913, Part III, page 79). This formula gives a mixture containing excess of lime. It is quite satisfactory for winter application, but the precipitate settles very quickly. This does not matter so much when the fluid is applied with a machine fitted with a mechanical agitator, but in the case of the pneumatic machines now recommended, it is of some consequence and is an objectionable feature. The formula given in the spraying pamphlet is now recommended. Where it is impossible to supervise the preparation properly, it will be found more satisfactory to employ Woburn Bordeaux paste.

Growth of tea seedlings in water culture solutions.—The fact that relations have been found to exist between the composition of a soil and the degree of susceptibility of tea bushes planted therein to *Helopeltis* attack suggests that if plants could be made to grow in water culture solutions, the composition of which was accurately known, and then exposed to the attack of the pest, useful data might be obtained which would aid in the discovery of the controlling factors. As no previous work has been done in this connection, it has first been found necessary to experiment with various water culture solutions in order to find a suitable medium for tea. Three soil solutions, the formulæ of which are given below, were tried. The plants put into solution No. 1, died off rapidly, the medium being evidently unsuitable. Those put into solution No. 2, lived for a time, but did not flourish, and made no new growth. The plants in solution No. 3, however, made growth and did well.

WATER CULTURE SOLUTION No. 1.—Formula taken from Loew: "The Physiological Role of Mineral Nutrients in Plants," U. S. Dept. Ag., Bur. Plant Ind., Bull. No. 45, 1903.

	Parts per 1,000.
Potassium nitrate	0·2
Calcium nitrate	0·2
Sodium sulphate	0·1
Magnesium sulphate	0·1
Potassium hydrogen phosphate ...	0·1
Ferrous sulphate	trace.

WATER CULTURE SOLUTION No. 2.—Formula taken from Hall: "Fertilisers and Manures," p. 16.

	Parts per 1,000
Calcium nitrate	0·7
Potassium phosphate	0·6
Potassium chloride	0·8
Magnesium sulphate	0·3
Ferric chloride	trace.

WATER CULTURE SOLUTION No. 3.—Formula taken from "The Journal of Agricultural Science," Vol. V, p. 232.

	Parts per 1,000.
Calcium nitrate	1·00
Potassium chloride	0·25
Magnesium sulphate	0·25
Potassium hydrogen phosphate ...	0·25
Ferric chloride	trace.

E. A. A.

The Scientific Study of Tea in Java:—Since the year 1908 investigations relating to tea culture in Java have been recorded in the Mededeelingen van het Proefstation voor Thee (Reports of the Experimental Station for tea).

It may be of interest to tea planters in India to know what subjects have been investigated. The following is a complete list of these reports :—

I.	Bernard and Welter.	Bibliographical review I. ...	1908
II.	Bernard ...	Diseases of the tea plant (preliminary report).	1909
III.	Bernard ...	The diseases of the tea plant caused by mites.	1909
IV.	Welter ...	The influence of drying on the quality of tea.	1909
V.	Bernard ...	Concerning the presence of yeast-like organisms in fermenting tea and their possible influence on the fermentation process.	1909
VI.	Bernard ...	Some additional remarks concerning the mites of the tea plant.	1910
VII.	Bernard ...	Experiments on the germination and selection of tea seed.	1910
IX.	Bernard ...	On a disease of young tea plants ...	1910
X.	Welter ...	A new tea roller	1910
XI.	de Bie and Bernard.	The cultivation of tea by the indigenous population.	1910

XII.	Bernard and Welter.	Concerning the presence of oxydizing ferments in fermenting tea and their possible influence on the fermentation process (Part I).	1911
XIII.	Ditto ...	Ditto (Part II). ...	1911
XIV.	van Leersum	Grafting of tea	1911
XV.	Welter ...	Further investigation of an oxidizing ferment which is present in tea leaf.	1911
XVI.	Welter ...	A new withering machine ...	1911
XVII.	Staub ...	(*a*) A contribution to the study of *Helopeltis*. (*b*) Some parasites of the tea plant.	1912
XVIII.	Staub ...	Investigations of the Micro-organisms which occur in fermenting tea (Summarized by Deuss from the original German publication in the Bulletin du Jardin botanique de Buitenzorg No. V).	1912
XIX.	Bernard and Deuss.	Bibliographical review (II) ...	1912
XX.	Bernard ...	Report of a journey to Ceylon and British India to study tea culture.	1912
XXI.	Bernard and van Leersum.	The selection of tea plants (I) ...	1913
XXII.	Bernard and Deuss.	The control of imported tea seed (I)	1913
XXIII.	Bernard ...	Report of the Experimental station for tea for the year 1912.	1913
XXIV.	Reijnst ...	Tea culture on a small scale.	
	Bosscha and Maurenbrecher.	Experiments with tannin carried out at Malabar.	1913
XXV.	Bernard and Deuss.	The tarring of pruning cuts on tea bushes.	

	Bernard and Deuss.	Manurial experiments on tea gardens (I).	
	Bernard ...	*Lucaena glauca* as green crop plant in tea gardens.	
	,, ...	Note on a disease of tea ...	1913
XXVI.	Bernard and Van Leersum.	The selection of tea plants (II) (details about grafting).	1913
XXVII.	Deuss ...	Preliminary report on tea tannin ..	1913
XXVIII.	Bernard ...	Report of the Experimental Station for tea for the year 1913.	1914
XXIX.	Bernard ...	Report on a journey to the east coast of Sumatra and the Padang highlands to study tea culture.	1914
XXX.	Bernard and Deuss.	Manurial experiments in tea gardens (II).	1914
	Bosscha ...	Manurial experiments carried out at Malabar.	1914
XXXI.	Deuss ...	Short review of the investigation of Dr. P. Van Romburgh, C. E. J., Lohmann, and Dr. A. W. Nanninga (1892-1906.)	1914
XXXII.	Bernard ...	"Red Rust" Preliminary observations on a disease of the tea plant caused by *Cephaleuros virescens.*	
	Kerkhoven	Some observations relating to "Red Rust" on tea bushes.	1914
XXXIII.	Deuss ...	Tea seed oil	1914
XXXIV.	Bernard ...	Report of the Experimental Station for tea for the year 1911.	1915
XXXV.	Leefmans ...	The tea seed fly and methods of control.	1915

The Propagation of Green Manure Plants by Cuttings.—Many plants which are in common use as green manures are suitable for propagation by cuttings. It will readily be seen that there are many advantages in this method. First of all it reduces

the amount of seed required, and secondly if the operation be carried out in suitable weather there is a greater certainty of a satisfactory crop.

It may be found desirable to sow seed in specially prepared seed beds and then in the rainy season take cuttings from the plants and plant them out in the tea. Pushing plant cuttings into wet soil is not an operation which requires much skill and the labour involved would be very small.

A. C. T.

The use of the blow lamp.—Attention has been drawn lately to the possibility of a blow lamp being useful on tea gardens. The three uses which suggest themselves are :—

(*a*) Burning jungle in the neighbourhood of young plants to prevent their being choked at a time when clearances cannot be attended to properly by forking and hoeing and jungle is growing rapidly :

(*b*) Burning moss, lichens, and other epiphytic plants growing on the branches of tea bushes :

(*c*) Burning away snags, *i.e.*, as an adjunct to the use of the ordinary pruning implements.

The value of the blow lamp for one or all of these purposes is at present problematic, but appeals to us as being worthy of investigation, which will accordingly be made.

G. D. H.

C. O. P.—1100—13-5-1915.